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PART 3 MAGNETIC PARTICLE INSPECTION METHOD

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MACROSCOPIC METHODS FOR DETERMINATION OF NON-METALLIC INCLUSION CONTENT IN WROUGHT STEELS

PART 3 MAGNETIC PARTICLE INSPECTION METHOD

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MACROSCOPIC METHODS FOR DETERMINATION OF NON-METALLIC INCLUSION CONTENT IN WROUGHT STEELS

PART 3 MAGNETIC PARTICLE INSPECTION METHOD

0. FOREWORD

0.1 This Indian Standard (Part 3) was adopted by the Indian Standards Institution on 10 October 1983, after the draft finalized by the Metallography and Heat Treatment Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard has been prepared to provide a method for evaluating and expressing the size and distribution of non-metallic inclusions in wrought steel products by macroscopic methods, which are the methods dealing with determination of non-metallic inclusions visible to the naked eye or with the aid of a magnifying glass with magnification of not more than $\times 10$.

0.3 This standard is being issued in three parts consisting of three different macroscopic methods, generally used for the determination of non-metallic inclusions. This part covers the magnetic particle inspection method for the determination of non-metallic inclusions. The other two methods have been covered in the following parts.

Part 1 Blue fracture test method

Part 2 Step machined test method

0.4 In this standard only those inclusions which are equal to or greater than 1 mm in length are taken into consideration. The parameters characterising the non-metallic inclusions shall be their total number and their length or thickness. No distinction is made in this standard between the type of inclusions.

0.5 In the preparation of this standard, assistance has been derived from the following publications:

ISO 3763-1976 Wrought steels — Macroscopic methods for assessing the content of non-metallic inclusions. International Organization for Standardization.

SIS 111110 Methods for assessing the slag inclusions content in steels macroscopic methods. Swedish Standards Institution.

0.6 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard (Part 3) prescribes the method for determining the non-metallic inclusions in wrought steel by magnetic particle inspection method.

2. FIELD OF APPLICATION

2.1 Magnetic particle inspection is applicable to only ferro-magnetic steels. It is generally used for products such as slabs, bars, billets and tube rounds.

3. PRINCIPLE OF THE TEST

3.1 Non-metallic inclusion causes a distortion in the induced magnetic field. This distortion attracts and holds the ferromagnetic powder, giving visible indication.

3.2 It should be noted that other irregularities in the metal such as cracks, blow-holes and shrinkage cracks, also give an indication under magnetic particle inspection. Precautions should be taken to ensure that the readings obtained correspond properly to the non-metallic inclusions by means of a supplementary examination such as a dye penetrant test.

4. SAMPLING

4.1 The methods of sampling, the number of samples and their location shall be subject to agreement between the parties concerned. Normally the surface which is to be examined shall be in the longitudinal direction of the product. The type of the test piece used may vary according to the shape of the product and depending upon the examination carried out.

5. PREPARATION OF THE TEST SURFACE

5.1 In the case of bars, billets and rounds, the following examination surfaces may be chosen:

a) The surface of the product after a fine grinding,

b) An axial section of the product,

*Rules for rounding off numerical values (*revised*).

c) A step machined test piece shall be prepared as stipulated in **3.2.2** of Part II of this standard.

d) Cylindrical test pieces obtained by machining or forging and taken from a quarter of the section of the product, machining being carried out so that the axis of the porduct is included on the surface of the test piece; (*see* Fig. 1 and 2).

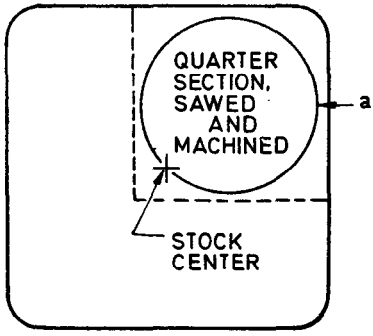

FIG. 1 QUARTER SECTION SPECIMEN FROM SQUARE SECTION FOR MAGNETIC PARTICLE TEST, MACHINE ONLY

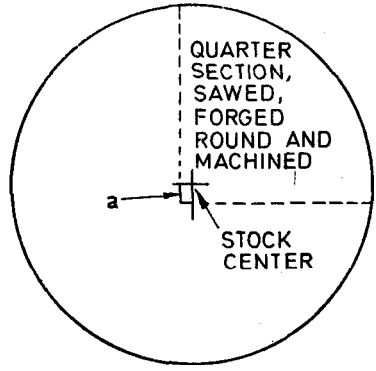

FIG. 2 QUARTER SECTION SPECIMEN FROM ROUND SECTION FOR MAGNETIC PARTICLE TEST, FORGING AND MACHINING

5.1.1 The first three types of examination surfaces are generally used for product of diameter or side less than 100 mm. The last type of examination surface is used for products having a larger section.

5.2 Preparation of the surface to be examined or of the test piece shall be carried out by fine grinding, perpendicular to the direction of the rolling in order to be able to distinguish any machining marks and to avoid tearing out the inclusions.

5.3 Care should be taken while preparing the surface to ensure that the smaller inclusions are not torn out.

5.4 The ends of the test piece should also be machined to facilitate magnetization.

5.5 In case, the test piece, have a heterogeneous structure, it may be necessary to carry out heat treatment of the test pieces prior to conducting the test.

6. TEST PROCEDURE

6.1 Magnetization — The test piece shall be magnetized by the current flow method by passing a current directly through the test piece. The type of current and the current intensity shall be subject to special agreement between the parties. In general a current intensity of 200 A/cm of the test piece diameter is found to be adequate.

6.1.1 Reference should also be made to IS : 3703-1966* for details of magnetization techniques.

6.2 Before the test, the surface shall be carefully cleaned with a solvent so that no trace of grease or any contamination remains.

6.3 The magnetizing current shall then be passed and the indicator fluid immediately poured over the entire surface, the current being maintained.

6.4 The surface shall then be carefully dried with an air jet and a volatile solvent, if necessary. In case of high hardness steels (50 *HRC* or 515 *HV*) application of the indicator should be made after magnetization of the sample.

6.5 It is recommended that the apparatus should be checked by means of control samples, to ensure that the control is completely sensitive.

7. ESTIMATION OF TEST RESULTS

7.1 For each step, the number of inclusions and their lengths shall be determined.

7.2 The distribution of inclusions in terms of their size may be obtained by using the classification given in Table 1.

TABLE 1 DISTRIBUTION OF NON-METALLIC INCLUSIONS BASED ON LENGTH

Length of the Inclusions mm	Weight Factor	No. of Indication
Over 1 to 2·5	1	N_1
Over 2·5 to 5	2	N_2
Over 5 to 10	4	N_3
Over 10 to 20	8	N_4
Above 20	16	N_5

*Code of practice for magnetic particle flaw detection.

7.3 Test results may be expressed in terms of frequency and severity value.

7.4 Frequency may be expressed as the total number of indications in a given area. A common area of 100 cm^2 may be taken for denoting the frequency.

7.5 Severity is the weighted value of the indications which may be taken as given in Table 1.

7.6 The severity value is calculated by multiplying the number of indications of a given length with weight factor and adding these results and is expressed as the weighted value per 100 cm^2. Thus for a specimen of total area A cm^2, the severity is expressed as

$$= \frac{(N_1 \times 1 + N_2 \times 2 + N_3 \times 4 + N_4 \times 8 + N_5 \times 16)}{A} \times 100$$